



## DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SPECIFICATION

Electron Tube, Cathode Ray, 22-inch, Metal Cone  
For Use in Computer Display Channel Plan View Display Console

### 1. SCOPE.

1.1 Scope. The metal cone cathode ray tube covered by this specification is round, 22-inches in diameter with magnetic major deflection angle of 62 degrees and electrostatic focusing. The faceplate will be bonded by an implosion panel as specified herein. The tube is to be used for the FAA National Airspace System (NAS) Computer Display Channel (CDC) Type FA-7912 Plan View Display (PVD) to display alphanumeric, symbolic and map data which will enable air traffic controllers to safely and efficiently control air traffic. This tube, when properly installed using the Installation Kit and Installation Procedure specified in FAA-E-2598 will serve as an alternative to the use of an all-glass, 23-inch diameter cathode ray tube which is specified in FAA-E-2573.

### 2. APPLICABLE DOCUMENTS.

2.1 FAA Standard. The following FAA standard of the issue in effect on the date of the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

(Copies of this specification, and of the applicable FAA standard may be obtained from the Federal Aviation Administration Contracting Officer issuing the Invitation for Bid or Request for Proposal. Requests should fully identify material desired, i.e., specification numbers, dates, amendment numbers; also requests should state the contract involved or other use to be made of the requested material.)

2.1.1 FAA Standard.

FAA-STD-013a Quality Control Program Requirements.

2.2 Military Specifications and Standards. The following Military specifications and standards of the issue in effect on the date of invitation for bids or request for proposals form a part of this specification to the extent specified herein.

2.2.1 Military Specifications.

MIL-E-1 () Electron Tubes, General Specifications for  
MIL-E-75 Electron Tube, Preparation for Delivery of  
MIL-R-3065 Rubber Fabricated Parts

(Specification MIL-E-1 (), which includes a large basic specification and over 1000 tube specification sheets, is not generally available. However, where adequate justifying statements are included in written requests directed to FAA (attention of the Contracting Officer), needed sections of MIL-E-1() may be obtainable. Requests should contain separate justifications for the basic specification (if needed) and for specific supplement sheets covering individual tubes. Unjustified requests for MIL-E-1 () cannot be processed.)

2.2.2 Military Standards.

MIL-STD-105 Sampling Procedures and Tables For Inspection by  
Attributes  
MIL-STD-1311 Test Methods for Electron Tubes  
MIL-STD-781 Reliability Tests: Exponential Distribution

2.3 Industry Specifications. The following specifications of the issues in effect on the date of invitation for bids or request for proposals form a part of this specification to the extent specified herein.

Glass Tempering Association Specifications:

GTA62-8-7 Safety Windows for Laminating to TV Tubes

(Individual copies of the above specification may be obtained by request: from the Glass Tempering Association, 1325 Topeka Avenue, Topeka, Kansas 66612 Attention: Raymond Eurick, Executive Director. Phone: Area Code 913 234-5715.)

2.4 Application of Subparagraphs. Wherever, in this specification and in the applicable documents (section 2), reference is made to a specific portion of a document (e.g., section, paragraph or subparagraph), it shall be understood that all subportions and subparagraphs thereunder shall apply also.

### 3. REQUIREMENTS.

3.1 Description. Electron tube, cathode ray, metal cone 22-inch diameter, magnetic deflection, electrostatic focus, deflection angle of 62 degrees, and faceplate with laminated safety glass as specified herein.

3.1.1 Dimensions and pin connections. Dimensions and pin connections shall be as shown in Figure 1.

3.2 Ratings. Ratings shall be as listed below. All voltages with respect to cathode with the exception of the filament voltage.

Parameter:	Ef	Eb1	Eb2	Ec1	Ec2	Ehk	Ib1
Units:	Vac	kVdc	kVdc	Vdc	Vdc	Vdc	uA
Maximum:	6.93	20	4	0	850	+200	300
Minimum:	5.67	10	.2	-170	500	-200	0
Test Cond:	6.3	18	focus	adjust	600	---	---

where Ef= filament or heater voltage  
 Eb1= anode voltage  
 Eb2= focusing voltage  
 Ec1= grid 1 voltage  
 Ec2= grid 2 voltage  
 Ehk= heater-cathode voltage  
 Ib1= beam current (in the beam) after leaving the gun and incident on the screen.

3.3 Materials. Materials and processes used in the construction of the tubes shall be in accordance with MIL-E-1 ()and the following:

The tube cone shall be made of steel meeting the requirements of SAE Standard 51446. It shall have a glass faceplate and glass cone to neck funnel assembly. It shall have a tempered glass laminated safety panel (as specified in GTA 62-8-7, Safety Windows for Laminating to TV Tubes, issued by the Glass Tempering Association). Bonding resin shall be number TV-720 with hardener number DEH-66 (DOW Chemical Company), or PPG 5234 Resin and Suitable Hardner (Pittsburg Plate Glass Company), or equivalent.

3.3.1 Holding Period. There shall be a 72-hour holding period prior to shipment to allow proper jell of PPG resins, if used.

3.3.2 Delaminations. There shall be no delaminations in the useable viewing area of the CRT during the contract CRT warranty period.

3.3.3 Anode Connection. An anode connection to the metal cone shall be provided by means of conductive paint applied to the surface area as shown in Figure 1. The coating shall be semi-permanent such that it will not flake or rub off during normal handling.

3.3.4 Faceplate Luminous Quality. The luminous transmission at centerface shall be 77.5 percent  $\pm 3$  percent. The luminous transmission at faceplate edge, measured at any point around a 9.625-inch radius shall be within 5 percent of the centerface transmission.

3.3.5 Faceplate and Bonded Safety Panel Combined Luminous Quality. The calculated combined luminous transmission of the faceplate and bonded safety panel shall be a minimum of 65 percent at all points over the useable screen area.

3.3.6 Screen Material. Screen material (aluminized) shall be P31 phosphor.

3.3.7 Lamination Plate and Epoxy Layer Thickness. The lamination plate thickness shall be 0.188  $\pm 0.031$  inches. At least two spacers between the faceplate and the safety panel shall be used in the lamination process to determine the thickness of the epoxy layer. Spacer dimensions shall be 0.06 to 0.08-inch diameter.

3.4 Marking. Marking shall be permanent and legible as described in Method 1105 of MIL-STD-1311. It shall include the manufacturer's name or symbol, type number, serial number, lot number, date code, part number and a space for marking the date of installation.

3.4.1 Lamination Notation. A characteristic red color shall be used on the base of the tube, shall be visible when viewing the side of the base and shall denote the tube as being safety laminated.

3.5 Blemishes. Blemish criteria shall be as described in method 5106 of MIL-STD-1311, except that the number and sizes of spots, holes and blemishes shall not exceed the specifications below.

3.5.1 Faceplate.

- (a) Finish - outside face Corning Glass Works laminate quality. Inside face to be "Mini-Stippled" to a surface roughness of 10-30 micro-inches r.m.s. as measured on a profile coder.
- (b) Quality Area - 20.00-inch diameter circle concentric with panel center.
- (c) Glass Quality - all provisions of Corning Glass Works general quality provisions for black and white television as found in page B30.00, sheets 1-7 are applicable with the following exceptions:

(1) Seeds, stones, opaque spots or similar defects within the quality area.

<u>Size</u>	<u>Maximum Number</u>	<u>Separation</u>
0.009" or less	Disregard	-
0.010" - 0.020"	9	0.500" Minimum
0.021" - 0.050"	7	1.000" Minimum
0.051" and over	None Allowed	-

The faceplate may have a total of 16 defects with not more than 7 of size .021" to .050" as described above.

3.5.2 Phosphor Screen and Faceplate Combined. Size and number of spots (holes and opaque spots).

<u>Size</u>	<u>Maximum Number</u>	<u>Separation</u>
0.009" or less	Disregard	-
0.010" - 0.020"	12	0.500" Minimum
0.021" - 0.050"	10	1.000" Minimum
0.051" and over	None Allowed	-

The phosphor screen and faceplate combined may have a total of 22 spots with not more than 10 of size .021" to .050" as described above.

3.5.3 Lamination Panel. Size and number of spots (opaque and dead).

<u>Size</u>	<u>Maximum Number</u>	<u>Separation</u>
0.009" or less	Disregard	-
0.010" - 0.020"	7	2" Minimum
0.021" - 0.050"	4	2" Minimum
0.051" and over	None Allowed	-

The lamination panel may have a total of 11 spots with not more than 4 of the size .021" to .050" as described above.

3.5.4 Total Number of Combined Spots for Phosphor Screen, Faceplate, Resin and Lamination Panel on Finished Tubes.

<u>Size</u>	<u>Maximum Number</u>	<u>Separation</u>
0.009" or less	Disregard	-
0.010" - 0.020"	19	-
0.021" - 0.050"	10	-
0.051" and over	None Allowed	-

The total number of spots shall not exceed 29 with not more than 10 spots of the size .021" to .050" as described above.

3.5.5 Elliptical Defects. For stones, bruises, dead spots, and similar defects the following equivalent diameter shall apply:

$$\frac{\text{length} + \text{width}}{2}$$

3.5.6 Allowable Surface Scratches. The following allowable surface scratches (1-inch maximum length) on the outer face of the laminated panel are as follows:

<u>Size</u>	<u>Maximum Number</u>	<u>Separation</u>
0.002" - 0.004"	4	1" Minimum
0.005" - 0.006"	2	2" Minimum
0.006" and over	None Allowed	-

The total number of surface scratches shall not exceed 6 with not more than 2 of the size .005" to .006" as described above.

3.5.7 Edge Chips. The maximum allowable dimensions of edge chips are:

0.125-inch wide - 0.188-inch long - 0.040-inch deep outside of useable area around periphery of laminated panel only.

3.5.8 Size and Number of Color Spots. Shall be in accordance with MIL-E-1 (), Appendix D.

3.6 Environmental Requirements. The tubes shall be capable of withstanding any combination of the following environmental conditions without mechanical damage or degradation of electrical/photometric performance (para. 3.7) beyond the limits specified.

3.6.1 Barometric Pressure. The CRT shall be capable of operating normally at 30.0 inches of mercury (sea level) to 16.8 inches of mercury (15,000 feet).

3.6.2 Relative Humidity. The CRT shall be capable of operating in a relative humidity from 0 to 95 percent including condensation ducts temperature changes.

3.6.3 Salt Atmosphere. The CRT shall be capable of operating in a salt atmosphere as found in coastal regions, and sea locations. This is a design objective and does not require an in depth test to MIL-STD-202.

3.6.4 Ambient Temperature. The CRT shall be capable of operating in ambient temperatures of +5 degrees to +65 degrees C. and shall withstand a storage temperature from -55 degrees C to +65 degrees C.

3.6.5 Vibration. Vibration shall be applied to these CRTs as described in MIL-STD-1311, Method 5111, at an amplitude of 0.020 inch. To determine the effect of the vibration, the electrical/photometric tests (para. 3.7) shall be performed on four tubes randomly selected by an FAA inspector from the earliest CRTs produced under the contract, before and after vibration, to assure that no degradation of tube performance results from this vibration (refer to paragraphs 4.4.1.3. The same testing applies for Type Testing (2 tubes, par 4.4.2.3).

3.7 Electrical/Photometric. The following operating conditions and ranges are listed below with all voltages specified relative to the cathode. The CRT shall be pre-heated per MIL-STD-1311 paragraph 4.8.6.1.

3.7.1 Anode Voltage. The operating anode voltage is +18 KVdc  $\pm 1$  KVdc.

3.7.2 Grid 2 Voltage. The operating grid 2 voltage is +600  $\pm 50$  Vdc.

3.7.3 Focus Voltage, Center Screen. The center screen focus voltage (Eb2 at 60 uA beam current is +2.8 KVdc  $\pm 0.20$  KVdc (See para. 3.11). Measurement shall be per Method 5246 of MIL-STD-1311.

3.7.4 Dynamic Focus Voltage Range. The dynamic focusing voltage range at screen edges is 450 Vdc maximum above center screen value.

3.7.5 Modulation. The maximum change in grid to cathode voltage required to change the anode current from 0.5 microamperes to 300 microamperes shall be 50 volts.

The maximum change in grid to cathode voltage required to change the anode current from 0.5 microamperes to 100 microamperes shall be 35 volts.

The minimum change in grid to cathode voltage required to change the anode current from 0.5 microamperes to 300 microamperes shall be 20 volts.

The minimum change in grid to cathode voltage required to change the anode current from 0.5 microamperes to 100 microamperes shall be 15 volts.

3.7.6 Screen Brightness Uniformity. The brightness uniformity measurement shall be made on an optimally focused DC positioned spot. The spot shall be generated by pulse-modulating the grid with a drive voltage which produces a brightness of 70  $\pm 7$  footlamberts average as measured across a line between 50 percent of full brightness points (specific for each tube to be tested). The refresh rate shall be 55  $\pm 0.55$  Hz and a writing rate of 0.5  $\pm 0.055$  inch per microsecond. A light output measurement shall be made at the center of the phosphor screen and at eight other locations as indicated by Figure 5. Each spot location shall be refocused for best round spot, and the light reading may not vary by more than 16 percent. The method of determining the variation shall be  $\frac{\text{Maximum-Minimum}}{\text{Average}} \times 100$  percent.

The measuring instrument viewing aperture must be at least 0.050 inch diameter, but not more than 0.375 inch.

3.7.7 Line Brightness. Brightness (measurements for adjusting the CRT) shall be made at the center of the screen on a single line by spot photometer using an approximate 12 mil aperture (effective diameter of the CRT screen) or an aperture calibrated in terms of equivalent energy of a Gaussian line with 12 mil 50 percent points. See para. 6.2.

The average worst case loading of the CRT while in operating will be:

<u>Beam Current (uA)</u>	<u>Percent of Time</u>
less than 1.0	45
15 to 50	55

3.7.8 Spot Growth. Utilizing the same method as in 3.7.6, size measurements shall be taken from edge-to-edge of spot. If the spot is not perfectly round use the average diameter  $\frac{\text{Length} + \text{Width}}{2}$ . The initial measurement is to be

made in the center of the screen at the deflection center. Eight other positions shall be observed at full-screen radius (points 1 through 8 of Figure 3). A measurement shall be made on the one point where spot growth is most apparent. The deflected spot may enlarge to no more than 150 percent of the center spot diameter when refocused within the allowable dynamic focus voltage limits. All size measurements are to be taken with a linear reticule direct reading microscope.

3.7.9 Line Width. The line width at center of the screen under the CRT operating conditions specified below, shall be measured with a Celco Twin Slit Analyzer or Gamma Scientific photometer with effective 2.4 mil maximum scanning aperture eyepiece. Measurement shall be taken between the lines' 50 percent of peak brightness points. The brightness shall be adjusted to 70  $\pm 7$  footlamberts and refresh rate of 55  $\pm 0.55$  Hz. Line width measurements shall be made in two planes 90° to each other.

<u>Eb1</u>	<u>Ib1</u>	<u>Ec2</u>	<u>Writing Rate</u>	<u>Line Width</u>
18KVdc $\pm$ 1KVdc	75uA $\pm 2.5uA$	600Vdc $\pm$ 50Vdc	0.5 in/us $\pm 0.055$ in/us	0.012 inch Maximum
18KVdc $\pm$ 1KVdc	200uA $\pm$ 10uA	- - - - - -	0.5 in/us $\pm 0.055$ in/us	0.020 Maximum

3.7.10 Cut-Off Voltage. Cut-off voltage shall be measured in accordance with Method 5241 of MIL-STD-1311. With the undeflected stationary spot correctly focused, the grid to cathode cut-off voltage required to visually extinguish the spot in a room ambient of 10 foot candles, or less, as measured with a meter held horizontally against the CRT face shall be between -35 and -85 Vdc with respect to the cathode.

3.7.11 Interelectrode Capacitance. The interelectrode capacitance shall be measured as described in Method 1331 of MIL-STD-1311 and shall not exceed the following:

Cathode (Ck) to all other elements ----- 5pf  
 Grid (Cg1) to all other elements -----13pf  
 Focusing Electrode (Cf) to all other elements ----10pf

3.7.12 Voltage Breakdown. Voltage breakdown shall be as described in Method 5201, paragraph 2 of MIL-STD-1311. In addition, the tube shall withstand the heater negative with respect to the cathode 200 Vdc maximum during a warm-up period not to exceed 15 seconds. After a total heating time of at least four (4) minutes, maximum operational voltages shall be applied for at least thirty (30) seconds after which a maximum of two (2) arcs shall be permitted, provided a second arc does not occur within three (3) minutes. No arcs shall be allowed thereafter.

3.7.13 Voltage Breakdown (Magnetic). The tube shall meet the requirements of MIL-STD-1311, Method 5201, paragraph 4, under the following conditions:

Eb1 = 20,000 Vdc  
Eb2 = 4,000 Vdc  
Ec1 = -170 Vdc  
Ec2 = 850 Vdc

3.7.13.1 Internal Arcing. In an ambient lighted area of less than 15 foot-candles, with Eb1 = 18 Kvdc, and the grid 1 bias adjusted to provide a faint raster, the number of arcs shall be zero after three (3) minutes of operation. Flashing within the raster area or arcing noise generated within the tube shall be construed as an indication of arcing.

3.7.14 Heater-Cathode Leakage Current. Heater-cathode leakage current shall not exceed 10 uA when measured in accordance with Method 5251.1 of MIL-STD-1311 under the conditions of +200 Vdc and -200 Vdc heater-cathode voltage.

3.7.15 Grid 1 Leakage Current. Grid 1 leakage current shall not exceed 3 uAdc as specified in Method 5251, paragraph 2 of MIL-STD-1311.

3.7.16 Grid 2 Leakage Current. Grid 2 leakage current shall not exceed 5 uAdc as specified in Method 5251, paragraph 3 of MIL-STD-1311.

3.7.17 Anode 1 Leakage Current. Anode 1 leakage current shall not exceed 5 uAdc as specified in Method 5251, paragraph 4 of MIL-STD-1311.

3.7.18 Stray Light Emission. Stray light emission shall be as specified in Method 5216, paragraph 2 of MIL-STD-1311, under the following conditions:

Eb1 = 20,000 Vdc  
Eb2 = 4,000 Vdc  
Ec1 = -170 Vdc  
Ec2 = 850 Vdc  
Ef = 6.3 V rms

3.7.19 Heater Current. Under the conditions specified in Method 1301 of MIL-STD-1311, the heater current shall be a minimum of 540 mA and a maximum of 660 mA.

3.7.20 Emission Build-Up. The emission build-up shall be a minimum of 70 percent where emission build-up is defined as:

$$\text{Percent Emission Build-Up} = \frac{\text{Ib2 at 30 seconds}}{\text{Ib2 at 60 seconds}} \times 100\%$$

3.7.21 Undelected Spot Position. The spot position (undelected), measured in accordance with Method 5231, paragraph 1 of MIL-STD-1311, shall fall within 0.25 inch diameter circle, the center of which coincides with the geometric center of the tube face.

3.7.22 Gas Ratio. Under the conditions specified in Method 5206 of MIL-STD-1311, the gas ratio shall be 0.10 maximum.

3.7.23 Focus Anode Current. Per Method 5201.1 of MIL-STD-1311 at Ib1 = 50 ua. Limit: 0 min, 20 ua maximum.

### 3.8 Mechanical.

3.8.1 Yoke Reference Line to Electron Gun. Minimum allowable distance between edge of Getter Cup or other conductive gun parts and yoke reference line is 3.125 inches.

3.8.2 Alignment-Neck and Faceplate. The maximum misalignment of the neck and the faceplate shall be 0.400-inch total indicated reading and the maximum facetilt shall be 0.375-inch total indicated reading when measured as follows on the bulb only (see Figure 2):

The bulb shall be supported vertically and rotated by a suitable test jig, similar to the one shown in Figure 2. The test jig shall cause the neck of the bulb to run true to the axis of rotation. The dial indicators shall be mounted perpendicular to the tube surface at the point of contact. The indicators shall be located as shown in Figure 2. The tube shall be rotated through 360 degrees and the maximum readings on all indicators observed. The maximum dial deviations shall be within the limits specified above.

3.8.3 Neck and Base Straightness. The neck and base straightness shall be determined by inserting the neck of the tube in a cylinder five inches long and 1.5 inch maximum inside diameter. The tube shall be considered acceptable for this parameter providing the cylinder can move freely from the reference line to the base of the tube.

3.8.4 Secureness of Base, Cap and Insert. Secureness of base shall be as specified in Method 1101 of MIL-STD-1311, latest applicable issue.

### 3.9 Safety Tests.

3.9.1 Frontal Impact. A blunt-nosed, (may be a ball or sphere), five pound steel weight on a chain shall be swung into the faceplate from a point five feet above the tube to produce 25 foot-pounds of force on the safety glass at a point half way between the center and the rim. This shall be performed on the same tube at the same place two times in succession. The tube shall not explode or implode; glass shall not be forcefully propelled or forcefully thrown outward from the tube face but shall disperse in a manner similar to an identical tube not under vacuum. If the tube cracks and slowly loses vacuum after two (2) impacts without collapsing and/or propelling pieces

of glass, the tube shall be deemed acceptable. If the tube slowly loses vacuum as a result of two (2) frontal impacts and is deemed acceptable, the neck impact test shall be performed on a second tube without performing frontal impact tests again. For the frontal impact test, the tube (except the tube face) shall be enclosed in a shatter proof container.

3.9.2 Gun and Neck Impact. If the tube vacuum is maintained after the above frontal impact test, a heavy piece of wood shall then be used to hit the tube on the end of the neck at the base, in a direction in line with the

faceplate. The tube shall not implode or explode violently, and the laminated glass shall not be damaged or cracked by the action of the gun or neck.

3.9.3 Completed Tube Pressure. The completed tube pressure test shall be in accordance with Method 1141 of MIL-STD-1311, except that a minimum of 45 psia shall be used. Failure at any pressure under 45 psia is unacceptable, and will be cause for rejection.

3.10 Reliability. The minimum acceptable mean time to failure (MTTF),  $\theta_1$  as described in MIL-STD-781B, shall be 5000 hours under the most stringent operating conditions specified in paragraph 3.6. A failure is defined as non-compliance with any of the electrical/photometric requirements given in paragraph 3.7 with the following qualification. Cathode ray tube brightness may decrease linearly from 70  $\pm 7$  foot lamberts minimum to 35  $\pm 3.5$  foot lamberts minimum, from zero to 5000 hours of "on" time under load conditions of para. 3.7.7. Brightness below 35  $\pm 3.5$  foot lamberts shall not be considered acceptable.

3.11 Center Screen Focus Voltage. Each CRT will be provided with its proper regulator tube taped to the CRT prior to shipping to the FAA. The high voltage regulator tube will be selected from the table below:

<u>CENTER SCREEN FOCUS VOLTAGE (<math>E_{b2}</math>)</u>	<u>VICTOREEN COROTRON* Type</u>
2600 v. to 2800 v.	GV5A-2400
2800 v. to 3000 v.	GV5A-2600

\*VICTOREEN Instrument Company registered trademark.

3.12 Deflection Yoke (Coil). The deflection yoke used for this CRT is a Syntronic C7535-1 Y73936 or latest replacement which can be obtained from the FAA on a loan basis for test purposes. The CRT and its particular yoke are matched for optimum display performance; therefore, this yoke or its equivalent shall be used by the contractor for FAA acceptance test purposes.

#### 4. QUALITY ASSURANCE PROVISIONS.

4.1 General. Unless otherwise specified in this cathode ray tube specification or in the contract, all tests and inspection to determine compliance with the electrical/photometric and mechanical requirements of the applicable specifications shall be made by the contractor at his plant and shall be subject to Government inspection. The term "Government inspection," as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspection as deemed necessary to assure compliance with contract requirements. The Government reserves the right to waive Government inspection at the con-

tractor's plant. If Government inspection is waived, the contractor shall furnish certified test data establishing proof of compliance with specification requirements. The test data must demonstrate that the tube meets contract requirements, include the statement "This certifies that this unit fully meets all technical requirements of the contract," and be dated and signed by a responsible official of the contractor. Shipment shall not be made until the contractor receives written Government approval of the submitted test data. The manufacturer shall comply with all of the quality control program requirements of FAA-STD-013.

4.2 Contractor's Preliminary Tests. Prior to the time the contractor formally notifies the Government that the initial production type tubes are ready for Government inspection, he shall make all tests which are necessary to prove compliance with this specification.

4.2.1 Preliminary Test Data. The contractor shall formally submit to the Government Contracting Officer a certified copy of the test data covering all preliminary tests made under paragraph 4.2. This test data shall be submitted together with (or in advance of) notification of readiness for inspection (4.2.2).

4.2.2 Notification of Readiness for Inspection. When the contractor has a CRT completed which meets all of these specifications, he shall formally notify the Government Contracting Officer that he is ready for Government inspection and tests. Upon acceptance of the test data (4.2.1), the Government shall notify the contractor when inspection shall start.

4.3 Visual Inspection. Prior to submittal for Government inspection and test (4.4), each tube to be delivered under the contract shall be visually inspected to determine general compliance with the requirements of this specification. This inspection includes checking for proper heater functioning and applicable mechanical inspection per MIL-E-1 ().

4.4 Government Inspection and Testing. Each tube shall be serialized or identified in accordance with paragraph 3.4. Following the holding period per MIL-STD-1311, paragraph 4.8.5 and preheating per MIL-STD-1311, paragraph 4.8.6.1, Government inspection and testing shall be performed as described below.

4.4.1 Design Qualification Tests. Twenty (20) to twenty-four (24) tubes from the initial production lot shall be subjected to the following tests. Failure to comply with the acceptance criteria shall be cause for suspending production until a plan for corrective action is agreed on by the contractor and procuring activity. The tubes used in these tests shall not be considered part of the deliverable quantity as specified in the contract.

4.4.1.1 Reliability Testing. Twelve (12) tubes shall be tested in accordance with Test Plan XX of MIL-STD-781B, Test Level A-1, to determine compliance with paragraph 3.10. Failed tubes shall not be repaired or replaced. Specific tests and failure analysis procedures shall be submitted to the government for their approval 30 days prior to the test. The detailed requirements of Section 5 of MIL-STD-781B shall generally apply.

4.4.1.2 Safety Testing. Four (4) to eight (8) tubes shall be tested in accordance with paragraph 3.9. No failures are allowed.

4.4.1.3 Vibration Testing. Four (4) tubes shall be tested in accordance with paragraph 3.6.5. No failures are allowed.

4.4.2 Type Testing (Sampling Tests). The following tests shall be performed for each production run. Failure to comply with the acceptance criteria shall result in rejection of the lot and production shall not resume until the contractor and procuring activity have agreed on a plan for corrective action. Unless otherwise specified in the production contract, an itemized lot shall consist of 200 CRTs based on a production rate of 80 per month minimum.

4.4.2.1 Reliability Testing. Twelve (12) tubes shall be randomly selected and tested in accordance with Test Plan VIII of MIL-STD-781B, Test Level A-1, to determine compliance with paragraph 3.10. Failed tubes shall not be repaired or replaced. Specific tests and failure analysis procedures shall be submitted to the government for their approval 30 days prior to the test. The detailed requirements of Section 5 of MIL-STD-781B shall generally apply. Tubes that comply with the above requirements shall be considered part of the deliverable quantity as specified in the contract or used to perform other type tests.

4.4.2.2 Safety Testing. A random sample of two (2) to four (4) tubes from each production run shall be tested as described in paragraph 3.9. No failures are allowed. These tubes shall not be considered part of the deliverable quantity as specified in the contract.

4.4.2.3 Vibration Testing. A random sample of two (2) tubes from each production run shall be tested in accordance with paragraph 3.6.5. No failures are allowed. These tubes shall not be considered part of the deliverable quantity as specified in the contract.

4.4.2.4 Secureness of Base, Cap, Insert and Permanence of Marking Tests. These tests shall be performed in accordance with Method 1101A and 1105 of MIL-STD-1311. Sample selection shall be based on a plan from MIL-STD-105D corresponding to inspection level S1 and an AQL of 6.5 percent. These tubes shall not be considered part of the deliverable quantity as specified in the contract.

4.4.3 Production Testing. The following tests shall be performed on each tube produced including those used in design qualification and type testing described in paragraphs 4.4.1 and 4.4.2. Failure to comply with the acceptance criteria shall result in rejection of the tube.

4.4.3.1 Mechanical Tests. These tests shall be performed in accordance with paragraph 3.8.

4.4.3.2 Brightness Uniformity Test. This test shall be performed in accordance with paragraph 3.7.6.

4.4.3.3 Electrical/Photometric Tests. These tests shall be performed in accordance with paragraph 3.7.

4.5 Inspection of Preparation for Delivery. Sample packages or packs, and the inspection of the preservation, packaging, packing and marking for shipment and storage, shall be in accordance with the requirements of Section 5.

5. PREPARATION FOR DELIVERY. Shall be per MIL-E-75. This includes drop test per MIL-P-116 and retest per method 1136 of MIL-E-1.

5.1 Preservation and Packaging. Preservation and packaging shall be level A or C, as specified in the procurement solicitation and contract.

5.1.1 Level C. For shipment to Aeronautical Center or Overseas, or direct shipment from vendor to a destination within the Continental United States, the CRT's shall be packed in an additional tri-wall box to allow for stack storage.

#### 6.0 NOTES.

6.1 Test Tables. Tables for quality conformance tests will be provided by the FAA contracting officer upon request.

6.2 Test Procedures. Test procedures (listing required equipment) used for brightness, line width and contrast measurements will be provided by the FAA contracting officer upon request.

\* \* \* \* \*

#### ATTACHMENTS

Figure 1. CRT Dimensional Drawing

Figure 2. CRT Test Jig and Faceplate Dimension

Figure 3. CRT Brightness Measurements

Design Qualification Tests

Type Testing (Sampling Tests)

Production Tests

Test Procedure

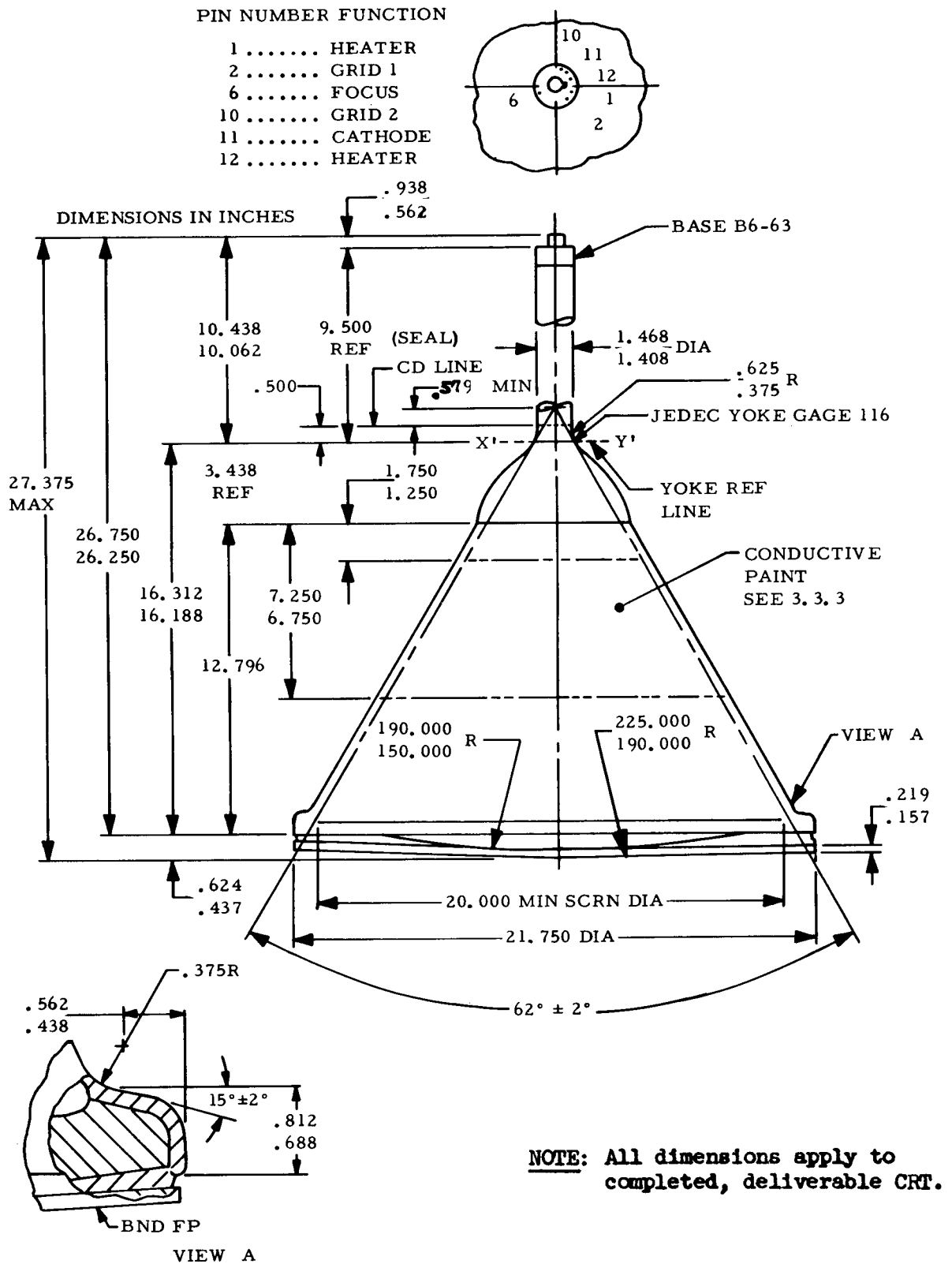
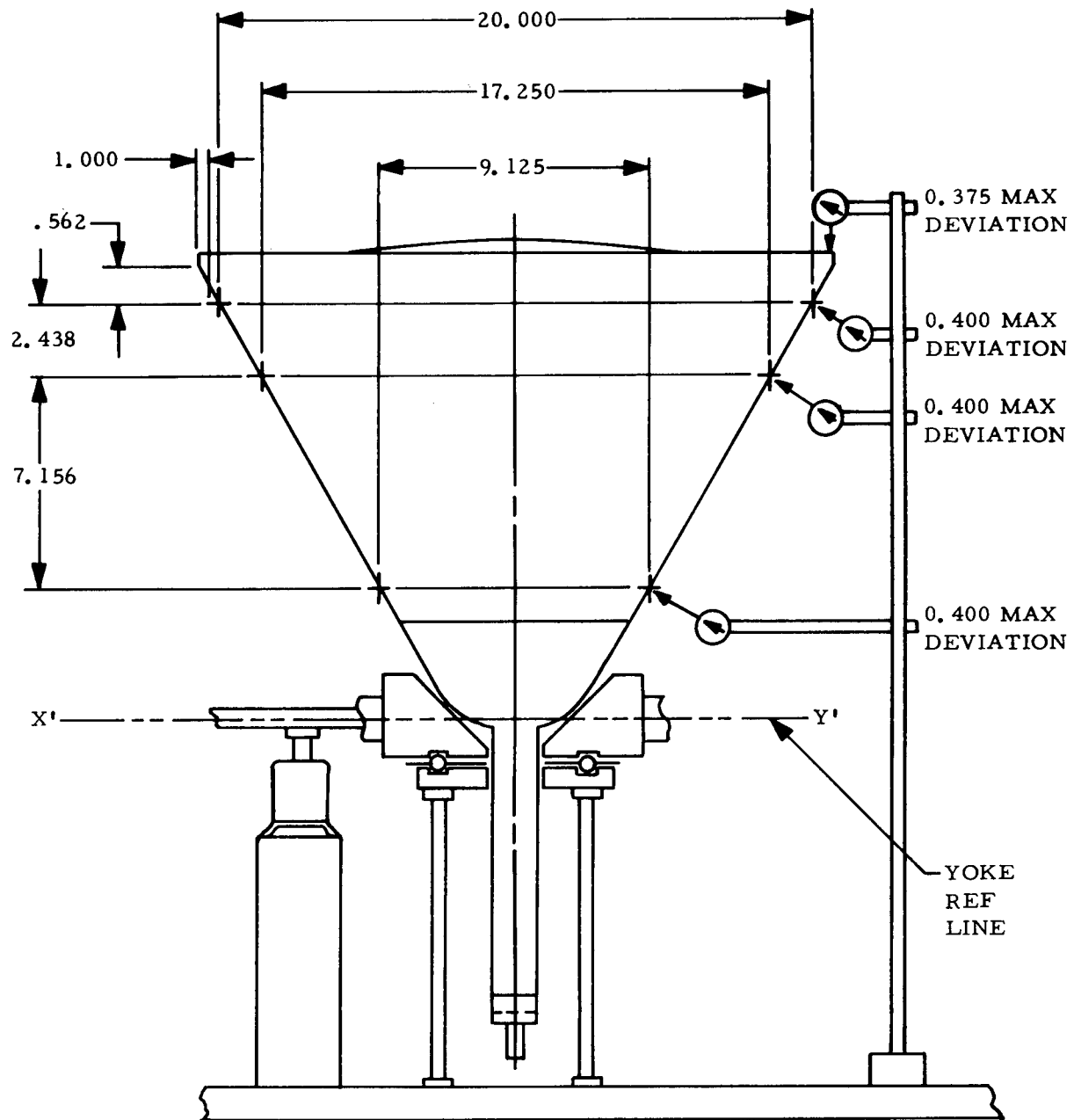


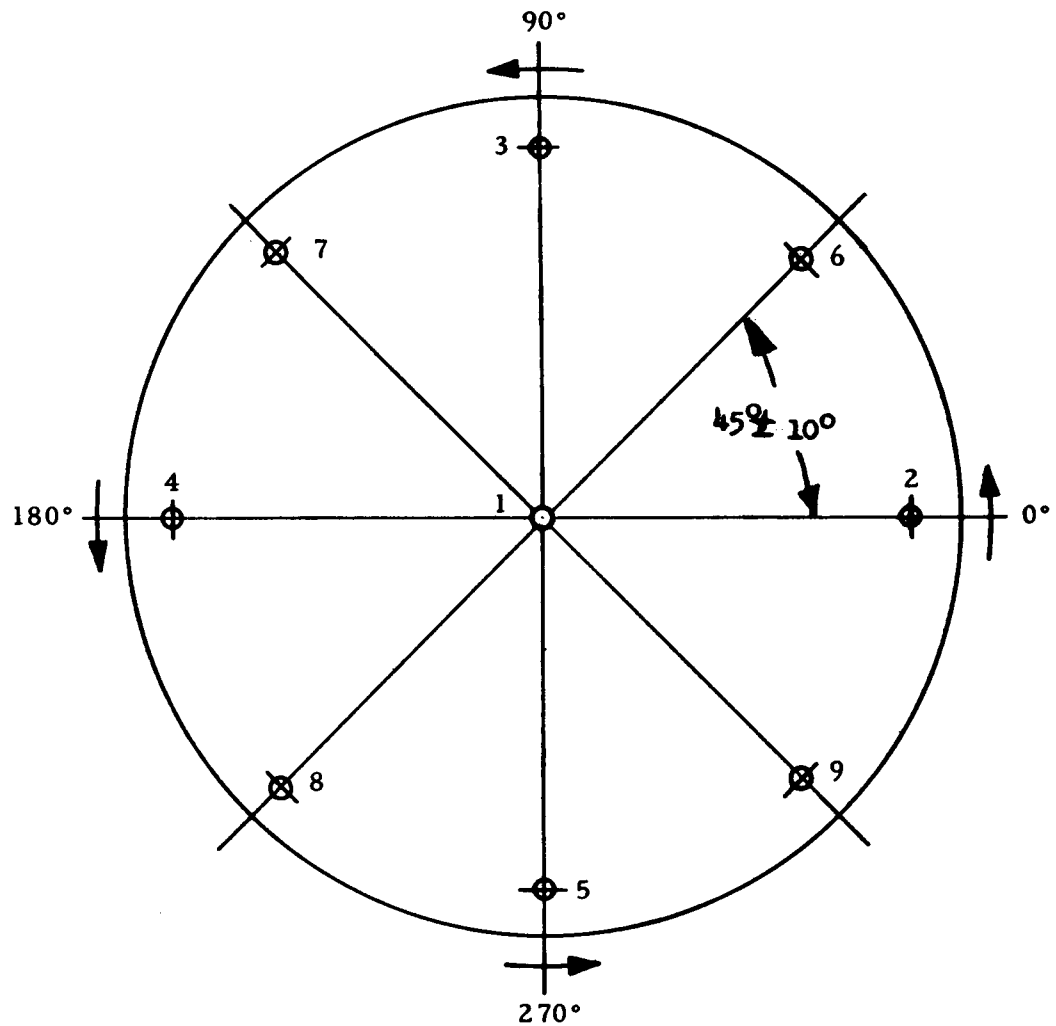
FIGURE 1. CRT DIMENSIONAL DRAWING



NOTE: All dimensions shown are in inches.

FIGURE 2. CRT TEST JIG AND FACEPLATE DIMENSION

### AREAS OF BRIGHTNESS MEASUREMENTS



NOTE:

POINT 1, CENTER OF SCREEN

POINTS 2-5, AT 90° INTERVALS ON 5.125-4.875 RAD

POINTS 6-9, AT 90° INTERVALS ON 9.500-9.250 RAD

FIGURE 3. CRT BRIGHTNESS MEASUREMENTS

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FEDERAL AVIATION ADMINISTRATION

TESTING OF:

22-Inch, Glass/Metal Cone Cathode Ray Tube for  
Use in Computer Display Channel Plan View Display  
Console, in accordance with Specification FAA-E-2597,  
latest issue.

Reference, Section 6 of FAA-E-2597 :

Paragraph 6.1-

- Design Qualification Tests
- Type Testing (Sampling Tests)
- Production Tests

Paragraph 6.2-

- Test Procedure

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22-Inch Glass/Metal Cone CRT for CDC PVDFor Use with Specification  
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## DESIGN QUALIFICATION TESTS

The first 20 to 24 tubes from the initial production lot.

## MIL-STD-1311

METHOD OR PARAGRAPH	REQUIREMENT OR TEST	CONDITIONS	SYMBOLS	LIMITS		UNITS
				MIN	MAX	
5216.2	Stray light emission	Normal operating conditions para. 3.7.18			none evident	
5201.1	Focus anode current	Ib1=60ua para.3.7.23		0	20	uAdc
5201.2	Voltage Breakdown	Para.3.7.12 Ecl=-170 V. Ehk=+200 V. Max. Rtg.			No breakdown	
5201.4	Voltage Breakdown	Para. 3.7.13			No breakdown	
5206.2	Gas Ratio	Para. 3.7.22	Gr	-	0.10	
5106.2	Blemishes	Para. 3.5			Limits per para.3.5	
	Brightness	Para. 3.7.6		63	77	Ft. L
	Brightness Uniformity	Para. 3.7.6		-	16	%
5223	Modul. ( $\Delta I_{An}= .5-100\mu A$ )	Para. 3.7.5	Ecl	15	35	Vdc
5223	Modul. ( $\Delta I_{An}= .5-300\mu A$ )	Para. 3.7.5	Ecl	20	50	Vdc
	Linewidth	Ib1=75uA Max. Para.3.7.9			0.012	Inches
		Ib1=200uA Max. Para.3.7.9			0.020	Inches
5231	Undelected Spot Pos.	Para. 3.7.21			0.250	Inches
5241	Grid Cut-off Voltage	Para. 3.7.10	Ecl	-35	-85	Vdc
5246	Focusing Electrode	Ib1=60uA				
	Voltage, Center Screen	Para. 3.7.3	Eb2	2.6	3.0	KVdc
5251.2	Grid No. 1 Leakage	Para. 3.7.15	Cgl		3.0	uAdc
	Internal Arcing	Para. 3.7.13.1			No flashing or arcing noise	
	Spot Growth	Para. 3.7.8			150	%
1301	Heater Current	Para. 3.7.19	If	540	660	mA
5251.1	Heater-Cathode Leakage	+200 V. Para. 3.7.14			10	uAdc
5251.3	Grid No. 2 Leakage	Para. 3.7.16			.5	uAdc
5251.4	Anode No. 1 Leakage	Para. 3.7.17			5	uAdc
1331	Direct-interelectrode Capacitance	Para. 3.7.11	Ck to All		5	pf
	Frontal Impact	Para. 3.9.1	Cgl to All		13	pf
	Gun and Neck Impact	Para. 3.9.2			Limits per 3.9.1	
1141	Completed Tube Pressure	Para. 3.9.3			Limits per 3.9.2	
	*Barometric Pressure	Para. 3.6.1	hg	45	16.8	psia
	*Relative Humidity	Para. 3.6.2		0.0	30.0	In/Mer
	*Salt Atmosphere	Para. 3.6.3			95	%
	*Ambient Temperature	Para. 3.6.4 - Operating			Coastal Regions & Sea Location	
		Para. 3.6.4 - Storage		+5	+65	Degrees
5111	*Vibration	Para. 3.6.5	Ampl.	-55	+65	Degrees
				-	0.020	Inch

\*RELIABILITY TESTING: Twelve (12) tubes shall be tested in accordance with Test Plan XX of MIL-STD-781B; Test Level A-1, to determine compliance with Para. 3.6.1, 3.6.2, 3.6.3, 3.6.4, and 3.6.5 of FAA Spec.

Also, Production Tests shall be a part of these Design Qualification Tests (see separate table of production tests herewith)

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## TYPE TESTING (SAMPLING TESTS)

The following tests shall be performed for each production run.

## MIL-STD-1311

METHOD OR PARAGRAPH	REQUIREMENT OR TEST	CONDITIONS	SYMBOLS	LIMITS		UNITS
				MIN	MAX	
5216.2	Stray light emission	Normal operating conditions para. 3.7.18			none evident	
5201.1	Focus anode current	Ib1=60uA para.3.7.23 Ehk=+200 V. Max. Rtg.		0	20	uAdc
5201.4	Voltage Breakdown	Para. 3.7.13			No breakdown	
5206.2	Gas Ratio	Para. 3.7.22	Gr	-	0.10	
5106.2	Blemishes	Para. 3.5			Limits per para.3.5	
	Brightness	Para. 3.7.6		63	77	Ft. L
	Brightness Uniformity	Para. 3.7.6		-	16	%
5223	Modul. ( $\Delta I_{A_n} = .5-100\mu A$ )	Para. 3.7.5	Ec1	15	35	Vdc
5223	Modul ( $\Delta I_{A_n} = .5-300\mu A$ )	Para. 3.7.5	Ec1	20	50	Vdc
	Linewidth	Ib1=75uA Max. Para.3.7.9 Ib1=200uA Max. Para.3.7.9			0.012 0.020	Inches
5231	Undelected Spot Pos.	Para. 3.7.21			0.250	Inches
5241	Grid Cut-off Voltage	Para. 3.7.10	Ec1	-35	-85	Vdc
5246	Focusing Electrode	Ib1=60uA				
	Voltage, Center Screen	Para. 3.7.3	Eb2	2.6	3.0	KVdc
5251.2	Grid No. 1 Leakage	Para. 3.7.15	Cg1		3.0	uAdc
	Internal Arcing	Para. 3.7.13.1			No flashing or arcing noise	
	Spot Growth	Para. 3.7.8			150	%
1301	Heater Current	Para. 3.7.19	If	540	660	mA
5251.1	Heater-Cathode Leakage	+200 V. Para. 3.7.14			10	uAdc
5251.3	Grid No. 2 Leakage	Para. 3.7.16			5	uAdc
5251.4	Anode No. 1 Leakage	Para. 3.7.17			5	uA
1331	Direct-interelectrode	Para. 3.7.11	Ck to All		5	pf
	Capacitance	Para. 3.7.11	Cg1 to All		13	pf
	Frontal Impact	Para. 3.9.1			Limits per 3.9.1	
	Gun and Neck Impact	Para. 3.9.2			Limits per 3.9.2	
1141	Completed Tube Pressure	Para. 3.9.3		45		psia
	*Barometric Pressure	Para. 3.6.1	hg	16.8	30.0	In/Merc.
	*Relative Humidity	Para. 3.6.2		0.0	95	%
	*Salt Atmosphere	Para. 3.6.3			Coastal Regions & Sea Location	
	*Ambient Temperature	Para. 3.6.4 - Operating		+5	+65	Degree
		Para. 3.6.4 - Storage		-55	+65	Degree
5111	*Vibration	Para. 3.6.5	Ampl.	-	0.020	Inch

\*RELIABILITY TESTING: Twelve (12) tubes shall be randomly selected and tested in accordance with Test Plan VIII of MIL-STD-781B, Test Level A-1 to determine compliance with paragraph 3.10 of FAA Spec.

Also, Production Tests shall be a part of these Type Tests (see separate table of production tests herewith)

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22-Inch Glass/Metal Cone CRT for CDC PVDFor Use with Specification  
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## PRODUCTION TESTS

Note: These tests are also performed on those tubes used in Design Qualification and Type Testing.

MIL-STD-1311		REQUIREMENT OR TEST	CONDITIONS	SYMBOLS	LIMITS		UNITS
METHOD OR PARAGRAPH					MIN	MAX	
5216.2	Stray light emission		Normal operating conditions para. 3.7.18			none evident	
5201.1	Focus anode current		Ib1=60ua para.3.7.23		0	20	uAdc
5201.2	Voltage Breakdown		Para.3.7.12 Ec1=-170 V. Ehk=+200 V. Max. Rtg.			No breakdown	
5201.4	Voltage Breakdown		Para. 3.7.13			No breakdown	
5206.2	Gas Ratio		Para. 3.7.22	Gr	-	0.10	
5106.2	Blemishes		Para. 3.5			Limits per para.3.5	
	Brightness		Para. 3.7.6		63	77	Ft. L
	brightness Uniformity		Para. 3.7.6		-	16	%
5223	Modul. ( $\Delta I_{An} = .5-100\mu A$ )		Para. 3.7.5	Ec1	15	35	Vdc
5223	Modul. ( $\Delta I_{An} = .5-300\mu A$ )		Para. 3.7.5	Ec1	20	50	Vdc
	Linewidth		Ib1=75 $\mu A$ Max. Para.3.7.9			0.012	Inches
			Ib1=200 $\mu A$ Max. Para.3.7.9			0.020	Inches
5231	Undelected Spot Pos.		Para. 3.7.21			0.250	Inches
5241	Grid Cut-off Voltage		Para. 3.7.10	Ec1	-35	-85	Vdc
5246	Focusing Electrode		Ib1=60uA				
	Voltage, Center Screen		Para. 3.7.3	Eb2	2.6	3.0	KVdc
5251.2	Grid No. 1 Leakage		Para. 3.7.15	Cg1		3.0	uAdc
	Internal Arcing		Para. 3.7.13.1			No flashing or arcing noise	
	Spot Growth		Para. 3.7.8			150	%
1301	Heater Current		Para. 3.7.19	If	540	660	mA
5251.1	Heater-Cathode Leakage		+200 V. Para. 3.7.14			10	uAdc
5251.3	Grid No. 2 Leakage		Para. 3.7.16			5	uAdc
5251.4	Anode No. 1 Leakage		Para. 3.7.17			5	uA
1331	Direct-interelectrode		Para. 3.7.11	Ck to All		5	pf
	Capacitance		Para. 3.7.11	Cg1 to All		13	pf
	Yoke Reference Line to electron gun		Para. 3.8.1			3.125	Inches
5105	Alignment-Neck and Faceplate		Para. 3.8.2		Misalignment	0.400	Inches
5101.8	Face Tilt			Face Tilt		0.375	Inches
5101.9	Neck and Base		Para. 3.8.3			Cylinder moves freely	
	Straightness Secureness of Base, Cap and Insert		Para. 3.8.4			(See para. 3.8.4)	

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22-Inch Glass/Metal Cone CRT for CDC PVD

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TEST PROCEDURE

Brightness, Linewidth and Contrast Ratio Measurements

I. EQUIPMENT REQUIRED

In order to perform the tests as described herein, the following

Gamma Scientific Co. instrumentation is required:

<u>MODEL NO.</u>	<u>ITEM</u>
2020A	Photometer W/Reg. AC Supply (Meter Readout)
or 2400	Photometer W/Reg. AC Supply (Digital Display Readout)
700-3C	Fiber Optic Probe, 60 inch
2020-1	Photomultiplier Assembly
2020-1A	Correction Filter
2020-6	General Purpose
700-10	Photometric Microscope with X-Y Positioning
700-10-3	Microscope Stand
700-10-5	2.5X Microscope Objective
700-10-13	1X Microscope Objective
700-10-66	Microscope Scanning Eyepiece with 3 X 100 Mil Slit
700-10-33 (SPL)	Microscope Eyepiece Modified with 45 X 45 Mil Slit
220	Standard Lamp Source
220-1A	Luminance Standard Head
P31	Phosphor Simulation Filter

In addition to the above, the following assorted equipment is also required:

<u>MODEL NO.</u>	<u>ITEM</u>
Gamma Scientific SPL	15 Mil X 100 Mil Slit Mask Overlay for the 220 Luminance Head
Weston 703	Illumination Meter or Equivalent
Weston 9924	Multiplier Disc for Above Meter

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CONDENSATION OF PARAGRAPHS II THROUGH VI (Detailed Steps Which Follow)

II. Assemble the necessary equipment and prepare to calibrate. Warm up the photometer and the lamp source.

III. For line width tests skip this paragraph and continue with paragraph V.

For brightness measurements install the 15 mil slit mask and P31 phosphor simulation filter on the lamp window.

Adjust the photometer sensitivity to the value of foot-lamberts printed on the P31 filter while focused on the slit.

Remove the 15 mil slit mask from the lamp window and make range adjustments if required. Do not remove the P31 filter.

Compute the ratio of the readings with and without the slit and record the number (Call it X).

IV. Establish the brightness correction factor by finding the reading of the blank screen (Y) with the ambient light properly adjusted.

Compute the brightness correction factor with the equation  $Y - \frac{Y}{X}$

Add the resultant number to the desired value when setting up a display.

Subtract the resultant number from the readings obtained when seeking true brightness levels and when computing brightness variation.

V. Install the correct lenses for line width tests, adjust the photometer to a scale where at least a 1/2 scale reading is obtained at the line peak. Scan across the line to be measured stopping the scan when the reading on the photometer equals the peak reading divided by 2. Note the dial reading on the eyepiece. This reading is in millimeters and must be converted. Take the difference of the two 50 percent readings and multiply by 15.7 to obtain the line width in milli-inches.

VI. Compute contrast ratio as (1) the value of the background divided by X of para. III, 7 then (2) the true average line brightness divided by the number obtained in (1).

DETAILED STEPS

II. PRE-CALIBRATION

1. Assemble the Microscope stand and the X-Y positioner. For Plan View Display tests use the microscope adapter block adjusted for the long focal length for brightness tests and the short length for line width tests

2. Install the appropriate eyepiece and objective (45 X 45) mil eyepiece and 1X objective for brightness measurements, 3 X 100 mil scanning slit and 2.5X objective for line width measurements.

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Interconnect the Photometer, Photomultiplier and eyepiece. Energize and allow at least 20 minutes warm up with the aperture window of the photomultiplier closed.

4. Energize the lamp source and the 100 ft. lambert standard lamp (place in STANDBY) and allow it to warm up for 20 minutes.

5. Install the 15 mil slit mask and the P31 filter over the standard lamp window.

### III. CALIBRATION PROCEDURE\*

NOTE: For line width measurements it is unnecessary to calibrate the photometer against the standard source. Go direct to Paragraph V.

1. Place the standard in-line with the microscope and eyepiece.

2. Energize the Standard. (Switch to OPERATE) Depress the zero button on the lamp source and zero the meter with the zero adj. Release the button and again zero the meter with the intensity control. The lamp is now set for 100 ft. lamberts.

3. Set the range switch on the photometer to the 100 range for the 2020A Photometer and check the zero setting. If using a 2400 photometer, set the range switch to the 10 range. Adjust the zero pot - if necessary.

4. Set the range switch to the maximum sensitivity range and check the dark current. Adjust the dark current pot to re-zero the meter - if necessary. Return to 100 range for the 2020A or to the 10 range for the 2400 Photometer and recheck zero.

5. Focus the microscope on the slit over the standard. Open the photomultiplier aperture and adjust the sensitivity control for a foot-lambert reading corresponding to that printed on the P31 filter. For a 2020A Photometer use the 100 ft-lambert scale or the 1 range for a 2400 Photometer. Be certain the eyepiece aperture is centered as shown in Figure 1. The figure is a rough illustration only. The Image through the eyepiece may differ depending on aperture construction.

\* NOTE: Install the microscope lens cap whenever calibrating the photometer.

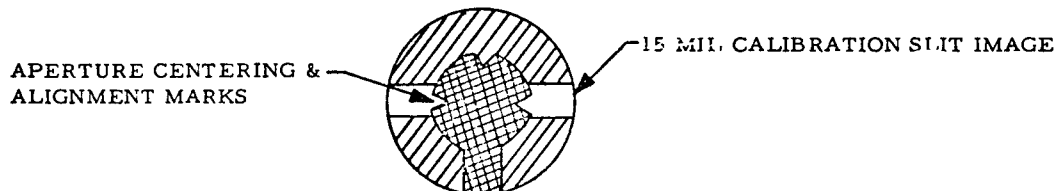


Figure 1 - View Through The Eyepiece

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6. Advance the photometer range switch to the 10 range for a 2400 Photometer. Do not advance for a 2020A. Without moving the microscope position relative to the lamp source window. Remove the 15 Mil Slit Mask from the source window. Do not remove the P31 filter.

Record the meter reading then shut the photomultiplier aperture and return the photometer range switch to 1.0 for a 2400 or leave in the present position for a 2020A Photometer.

7. Compute the ratio of the two readings of steps 5 and 6 using the following formula:

$$\frac{\text{NUMBER RECORDED IN STEP 6}}{\text{NUMBER RECORDED IN STEP 5}} = X$$

Record the above quotient (X) for use later on in step IV, 1c. The value of X should be between 2.0 and 4.0.

The instrument is now calibrated for brightness measurements on straight line segments. For reasonable measurement accuracy two provisions prevail. First, the expected line width should be within the range of 10 to 20 mils at the 50 percent of peak brightness points. Second, measured line segments should be straight and longer than 50 mils.

#### IV. BRIGHTNESS MEASUREMENT PROCEDURE\*

1. Prior to making actual measurements the effect of background light reflected from the phosphor surface must be established. Therefore, the following steps must be carried out.

a. Be certain the ambient light is adjusted to a level commensurate with the particular display test requirements.

b. Focus the Gamma microscope on the phosphor of the display under test in an area at least 1 inch away from displayed data but not in the bezel shadow. Open the photomultiplier aperture and record the level thus obtained. This number will be called Y. (For an FAA Plan View Display the value of Y will be between 6 and 10).

c. Solve the following equation using the value for X obtained in Paragraph III, 7 and the value for Y obtained in paragraph 1, b. above.

$$Y - \frac{Y}{X} = \text{brightness correction factor}$$

example:

for Y = 10, X = 2.5

$$10 - \frac{10}{2.5} = 5$$

---

\*NOTE: Install the microscope lens cap when making measurements.

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If the quotient has a remainder, round the number off to the nearest whole number.

example: 4.2 round off to 4  
          4.5 round off to 5  
          4.7 round off to 5

2. Brightness Measurements - To make a brightness measurement, position the microscope at the location desired and maximize the meter indication by use of the XY position controls of the microscope. Read the meter according to the provisions of 2, a. and 2, b. Remember to center the line within the aperture by aligning the mid-point of the line with the alignment marks. Also, be certain the line under test is parallel with a 45 mil dimension of the aperture. If the line segment being measured is not visible behind the eyepiece aperture pull out the fibre optic probe and look into the hole. The microscope can then be adjusted until the proper line segment is in the aperture. Plug in the fibre optic probe and peak the adjustment using the photometer readout. Install the lens cap when taking brightness readings.

2a. The brightness correction factor will be added to the desired brightness reading when adjusting a display to a specified level. Example: to set the brightness of a line or character segment to 50 foot-lamberts if the brightness correction factor is 6 the brightness is adjusted until the photometer reading is 56.

2b. The brightness correction factor will be subtracted from values obtained from various points on the screen when computing brightness variations or to determine the true brightness of a line segment. Example: if readings obtained around the screen are 56, 60, 62, 54 then the true brightness values are respectively 50, 54, 56, 48 foot-lamberts if the brightness correction value happens to be 6.

The percentage variation in brightness will be computed according to the method outlined in the particular system's test procedures.

NOTE: Close the photometer aperture when changing eyepiece for line width tests.

#### V. LINE WIDTH MEASUREMENTS

For line width measurements the photometer need not be calibrated against the standard source since the readings obtained will be relative to each other only.

1. Insert the 2.5X objective lens and the 3 X 100 scanning slit into the microscope.

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2. Position the microscope such that the line element under test is aligned parallel with the 100 mil slit dimension. Open the photomultiplier aperture window and switch the photometer range switch to a scale which gives at least 1/2 full scale response when the slit is scanned across the line peak.

3. To measure a line's width scan the slit across the line with the adjustment on the eyepiece until a maximum reading is indicated on the photometer. Divide the reading by 2 to obtain the line 50 percent point value. Scan to either side of the peak until the meter reads the peak value divided by 2 as computed. Record the eyepiece digital indicator reading. Scan to the other side of the line peak until meter reads the 50 percent value as before. Record the digital indicator reading. Subtract the smaller indicator reading from the larger and multiply by 15.7 to obtain the line width in mils.

NOTE: The lens cap must be over the eyepiece when readings are taken.

Example: The peak value obtained might be 30.  $\frac{30}{2} = 15$ . Therefore,

scan the slit across the line, to read 15 on one side of peak then 15 on the other.

The digital indicator might read 5.65 at one 50 percent point and 6.82 at the other 50 percent point. The difference in readings is 1.17.

$$1.17 \times 15.7 = \underline{18.4} \text{ mils (the line width)}$$

#### VI. CONTRAST RATIO

1. With the 45 X 45 mil slit and 1X objective installed, calibrate the instrument per paragraph III, steps 1 through 7.

2. Position the microscope as for a brightness reading and read the value of the screen background at the point(s) indicated in the test procedure.

3. Divide the background reading by the value X as obtained in step III, 7.

4. Divide the result of the above step 3 into the true average brightness reading of the displayed data. The result is the contrast ratio.

Example: During calibration obtain the value of X. Assume it is 2.5.

The background may read 10.  
Divide 10 by 2.5 to obtain 4.

Divide 4 into the average brightness of the display.  
If the average brightness is 50-foot lamberts then:

$$\frac{50}{4} = \underline{12.5} \text{ (contrast ratio)}$$